Final Report

on

Multiple Time Scale Numerical Simulations on Plasma Transport at the Earth's Magnetosphere

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Supported by the above NASA grant, one- and two-dimensional electromagnetic particle simulation codes were developed to study equilibrium and stability of the subsolar magnetopause curent layer. First structure of the current layer at the subsolar point was studied by means of a one-dimensional code (Okuda, 1991,1992). The code can handle self-consistent interaction of the incoming solar wind with the diple magnetic field. Both unmagnetized and magnetized solar wind plasmas were considered. It was found that: (1) the current layer is narrow and the width is given by the hybrid gyroradius in the absence of an IMF. (2) In the presence of a southward IMF, the current layer remains silimar to the case without an IMF. (3) In the presence of a northward IMF, the current layer is broadened significantly beyond the hybrid gyroradius.

One-dimensional simulation is extended into two dimensions in order to study stability of the current layer. Two-dimensional simulations in the equatorial plane in the absence of an IMF showed that the current layer is unstable with respect to high frequency drift instabilities (Berchem and Okuda, 1990). The simulation is extended to the sun-earth meridian plane and it was found that the current layer remains stable in that plane (okuda, 1993).

When a southward IMF is present in the solar wind, simulations in the equatorial and meridian planes revealed plasma instabilities leading to magnetic reconnection and plasma acceleration. In the meridian plane, the instability was identified as the collisionless tearing mode which is weak in a collisionless plasma. In the equatorial plane, magnetic reconnection and the plasma acceleration become more violent leading to plasma turbulence. We believe the difference arises from a presence of high frequency instabilities in the equatorial plane leading to generation of anomalous resistivity and enhanced reconnection (okuda, 1993). The current layer is found broadened significantly beyond the hybrid gyroradius due to the presence of these instabilities.

References

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